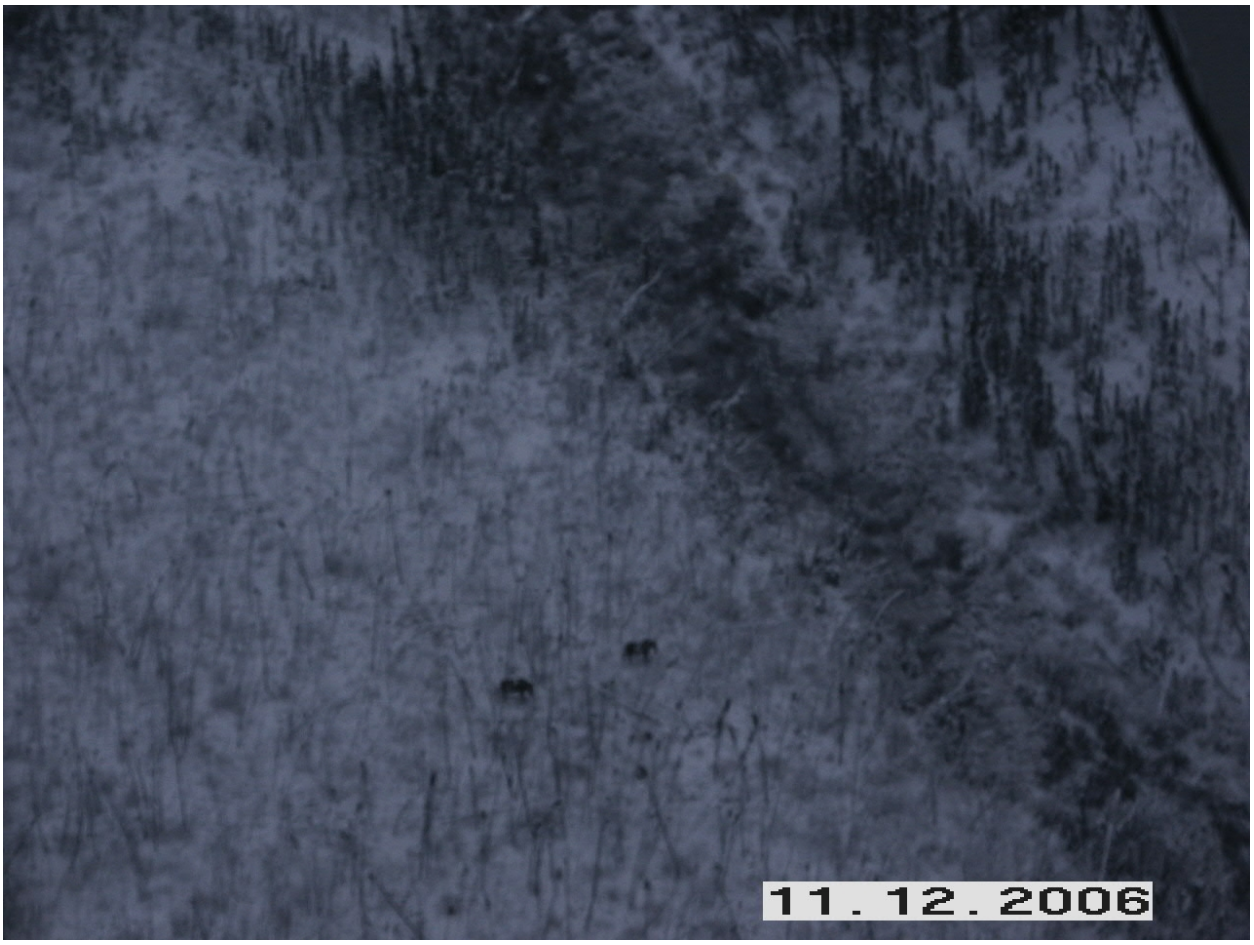
2006 AERIAL MOOSE SURVEY, YUKON-CHARLEY RIVERS NATIONAL PRESERVE, ALASKA

November, 2006

John Burch



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2006 AERIAL MOOSE SURVEY,
YUKON-CHARLEY RIVERS NATIONAL PRESERVE, ALASKA

PROJECT REPORT
November, 2006

JOHN BURCH, U.S. National Park Service, Yukon-Charley Rivers National Preserve & Gates of the Arctic National Park and Preserve, 4175 Geist Road, Fairbanks, Alaska 99709.

DATA SUMMARY:

Survey dates: November 6-12, 2006 (6.5 days of survey, 0.5 weather days)

Total survey area: 3,096 mi^2 (8,019 km^2), 555 survey units

Area surveyed: 841 mi^2 (2178 km^2), 151 survey units

Total moose observed: 180 (89 cows, 28 calves [5 set of twins], 63 bulls [6 spike-fork bulls])

Applied sightability correction factor = 1.2 (ADF&G radiotelemetry studies, GMU 20A, 2007)

Average search effort: 5.42 minutes/mi^2 (2.1 minutes/km^2)

* Population estimate: 726 moose +/-139 (587 – 865) (+/-19.17% at 90% CI)
(352 cows, 116 calves, 257 bulls [24 spike-fork (yrl) bulls])

* Estimated density: 0.234 moose/mi^2 (0.091 moose/km^2)

* Estimated age/sex ratios: 33 calves:100 cows, 14 yearlings:100 cows, 73 bulls:100 cows

Average harvest: 26 bulls per year (20 year average, preserve wide)

* 1.2 sightability correction factor applied

INTRODUCTION

The Central Alaska Network of National Park Service conducted an aerial moose survey during November 6-12, 2006, in Yukon-Charley Rivers National Preserve (YUCH), Alaska (Figure 1). The purpose of this survey was to estimate the moose population size and sex/age composition for the Yukon River corridor within YUCH. Moose population information is needed by

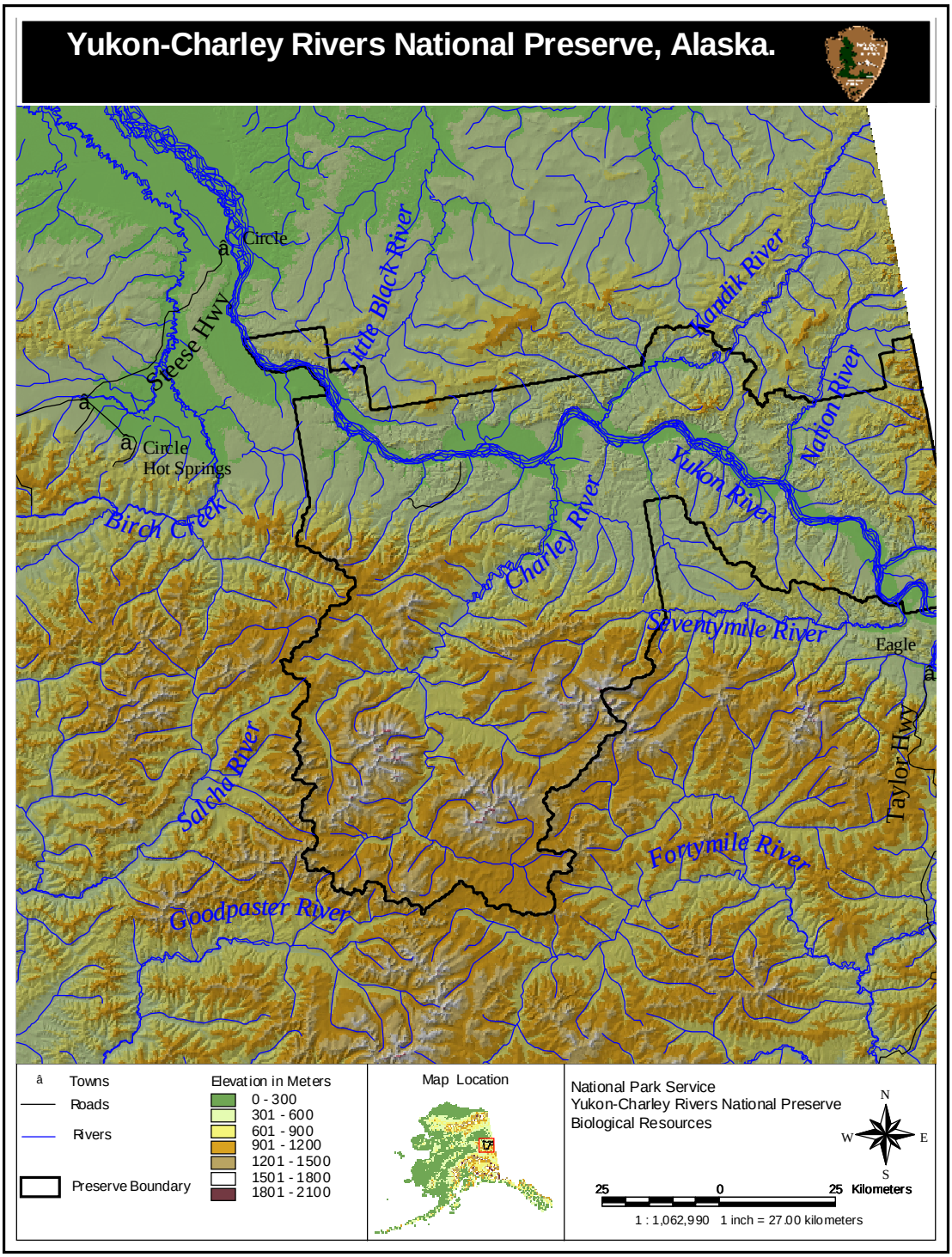

Figure 1. Location of Yukon-Charley Rivers National Preserve (YUCH), Alaska.

Preserve and state wildlife managers for monitoring long-term population trends and to make informed decisions regarding proposed changes to moose hunting regulations for this area. Several moose surveys have been conducted within the preserve during the last 28 years. In February 1975, a brief aerial survey was conducted along the Yukon River to identify winter habitat (Boertje 1985). During 1982-1987, trend counts were conducted in the Washington Creek area as part of an Alaska Department of Fish and Game (ADF&G) study investigating the role of predation in limiting moose densities in east-central Alaska (Gasaway et al. 1992). In November 1987, a large area along the Yukon River was surveyed between Eagle and Circle within YUCH (Nowlin 1988). A winter, moose habitat-use survey was conducted along the lower Nation River and Hard Luck Creek in March 1991 (Knuckles 1991). The entire Charley River drainage and the Yukon River corridor between Glenn Creek and Woodchopper Creek was surveyed in November 1994 (Demma et al. 1995). Sampling methodologies used during these past surveys varied. Consequently, the results of the older surveys (1970s, early 1980s, and 1994) are of limited use in determining long-term moose population changes in YUCH. The same Yukon River corridor area between Eagle and Circle, surveyed in 1987, was surveyed in 1997 (Burch and Demma 1997), 1999 (Burch 1999), 2003 (Burch 2003), and again during this survey, thus providing 5 surveys covering the same area that are directly comparable. This survey and the 2003 survey used the geo-spatial estimator (Ver Hoef 2001, Ver Hoef 2002, Kellie and DeLong 2006). The previous 3 surveys (1987, 1997, 1999) all used methods described by Gasaway et al. (1986) and surveyed the same area. All 5 surveys are directly comparable. In 1998, proposals to change harvest regulations were submitted by local subsistence hunters in Eagle. These proposed changes included a longer fall season and the addition of a March hunting season for qualified federal subsistence users. The longer fall season was adopted, but the March

season was not. In the past, residents of local communities have relied on caribou from the Fortymile Caribou Herd and moose for meat. The total harvest limit for Fortymile Caribou Herd caribou was reduced from 450 to 150 for 1996-2000 as a result of an interagency management plan developed to restore the caribou herd to its former range (ADF&G 1995). The reduction in harvest limits for caribou in the Fortymile Caribou Herd reduced the availability of caribou from this herd for all Alaska residents. Because of this harvest reduction, local residents were more dependent on moose for meat. Harvest opportunity of Fortymile caribou has now increased incrementally beginning in 2001 as outlined in the Fortymile caribou harvest plan (ADF&G, et al 2000) and has likely taken some human harvest pressure off YUCH's moose population. In spring 2006 the Board of Game endorsed a new Fortymile harvest management plan providing additional harvest opportunity, further reducing harvest pressure on the moose population. Despite this probable reduction in pressure, local residents have voiced concerns of competing with increasing numbers of non-local hunters for area moose during the general hunting seasons. The issue of subsistence vs. general hunting, and issues related to rural preference for local wildlife resources are controversial statewide. Resource conflicts of this nature will likely intensify as competition increases for limited wildlife resources in Alaska. Information provided by this survey (and others like it in the future) will assist managers in effectively evaluating future proposals regarding moose hunting and the moose population inhabiting YUCH. Regularly recurring fall surveys are crucial to monitoring this moose population. Analysis presented here indicate an increase in moose harvested and an increase in the number of people hunting in the Preserve. This increased harvest pressure is on a low density moose population, with poor recruitment. Past surveys indicate a low density, stable population, but the stability of the population is uncertain. Another survey in fall 2009 is recommended.

Incorporation of Moose Surveys into the Central Alaska Network (CAKN)

The Central Alaska Network (CAKN) has identified Fauna Distribution and Abundance as one of its top three vital signs. In general, CAKN wants to know where fauna are distributed across the landscape and to track changes in both their distribution and abundance. The Fauna Distribution and Abundance vital sign includes monitoring efforts for a suite of vertebrate species spanning the significant elevation gradient found in CAKN parks, and also including species of specific interest within each park. Moose (*Alces alces*), occur in all three network parks and are one of six large mammal species in interior Alaska. Moose are of great importance to people from both consumptive and non-consumptive viewpoints, and to the ecosystem as a whole. From a monitoring standpoint, moose are considered to be good indicators of long-term habitat change within park ecosystems because they depend on large scale, healthy habitats for food and cover, which in turn are dependent on weather and other habitat patterns across the entire landscape. As a top herbivore, moose may play a key role in influencing vegetation growth and change potentially resulting in habitat change on a landscape scale. Changes in moose populations directly affect subsistence harvest on NPS Park and Preserve lands in Alaska, and harvest by the general public on NPS Preserve lands (National Park Service 2003).

Moose are a species specifically identified in the enabling legislation and management objectives of all three CAKN parks (U. S. Congress 1980). Moose are important to park visitors because of the opportunities to view and hunt moose in Alaskan Parks and Preserves. While the primary objectives of monitoring is to track the distribution and abundance of moose in YUCH, these data are likely to be valuable for wildlife management and research throughout most of interior Alaska.

Data on moose populations in Alaska parks is critical for managing those populations for both visitor enjoyment and human harvest.

STUDY AREA

The moose survey was conducted along a 30-40 mile (48-64 km) wide corridor of the Yukon River drainage within YUCH, between Eagle and Circle, Alaska (Figure 2). The topography of the area consists mainly of rolling hills and river bluffs (Figure 3). Isolated rugged terrain occurs on several eroded mountains, with peaks generally under 6000 feet (1200 meters). Vegetation is dominated by black spruce (*Picea mariana*), and several species of deciduous hardwoods including aspen (*Populus tremuloides*) and birch (*Betula papyrifera*). Ponds, sloughs and large areas of tussock tundra are common in the flats along the Yukon River and lower parts of large tributaries such as the Charley and Kandik Rivers. Wildfire burns of varying sizes and ages are present throughout the study area (NPS 1985) including the more recent large fires from summer 1999 and 2004 along the Yukon, Nation and Kandik rivers. The Preserve's fire management plan (NPS 1999) contains a more in depth review of fire history for the area. YUCH's General Management Plan (National Park Service 1985) and an ecological unit mapping report (Swanson 1999) provide more thorough descriptions of the vegetation and physiography of the area.

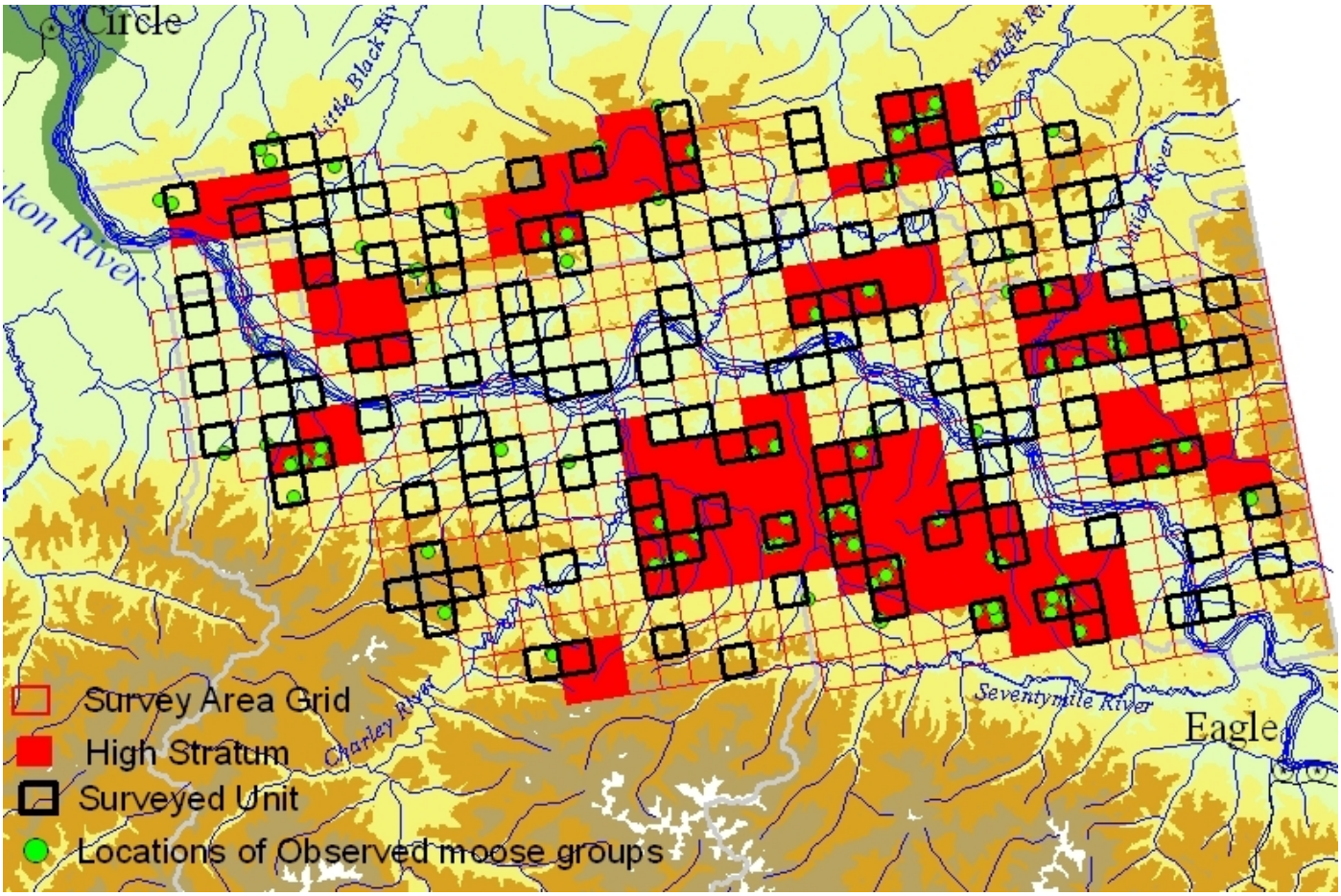

Figure 2. Location of the moose survey area and all survey units (red grid). Location of moose groups observed during the survey are depicted as green dots. Clear units were low stratum and red units were high stratum. Units with heavy black outline were surveyed in November 2006. Yukon-Charley Rivers National Preserve, Alaska.

Figure 3. Typical topography and vegetation of the survey area. Mouth of the Kandik River on Yukon River.

METHODS

This survey, a geo-spatial estimator, used methods described by Ver Hoef (2001), Ver Hoef (2002), Kellie and DeLong (2006) and Gasaway et al. (1986). In 2003, to follow the modifications suggested by Ver Hoef, the study area was reconfigured into a grid of 555 square survey units. Each survey unit averaged 5.58 mi^2. Units were delineated by 2 minutes of latitude by 5 minutes of longitude (Figure 4). Sample units were stratified into high (3 or more moose) or low (0 - 2 moose) moose densities based on moose locations from previous surveys, locations of wolf-killed moose, and knowledge of the local area. Stratification flights (Nowlin 1988, Demma et al. 1995, Burch and Demma 1997, Burch 1999) were not flown during 2003 or 2006. During the survey, up to four pilot/observer teams, in Piper PA-18, Christen Husky or Bellanca Scout aircraft surveyed sample units at a rate averaging 5.4 minutes per mi^2 (2.1 minutes/km^2). Moose

observed were assigned group numbers and mapped by recording coordinates of each moose group observed utilizing the aircraft's Global Positioning System (GPS) receivers. Numbers of moose in each group were recorded and the sex and age classification of each moose was determined. Moose were classified as: cow, calf, yearling bull (spike or forked antlers), medium bull (antler spread > spike/fork, but < 50 inches [127 cm]), and large bull (antler spread ≥50 inches [127 cm]). Total moose, moose density and sex/age ratios were calculated using the GeoSpatial Population Estimator software (DeLong 2006, Kellie and Delong 2006). The software 'MOOSEPOP' (Gasaway et al. 1986, Reed 1989), was used each night at our field camp (Coal Creek Camp) to track survey's progress and variability as the GeoSpatial software is not yet available 'off line'.

Sightability Correction Factor (SCF)

The GeoSpatial method assumes 100% sightability of moose during a survey (Ver Hoef 2001; Ver Hoef pers. comm., Kellie and DeLong 2006). The reality is something less. Previous stratified random surveys (Gasaway style) missed between 10% and 20% of the moose as measured by 30 – 40 intensive (12^+ minutes/mi^2) survey plots for each moose survey (40% of total plots surveyed). Tests run by Gasaway et al. (1986) indicate that on average, for early winter surveys, 98% of the moose are seen when surveying at a rate of 12 minutes/mi^2, and approximately 90% – 95% are seen when flying at a rate of 7 minutes/mi^2 in interior Alaska. This survey averaged 5.4 minutes/mi^2 of search time. ADF&G has been conducting tests in GMU 20A with radiocollared moose for the past 3 years, finding that more than 20% of the moose are missed in forested areas, and some moose are not seen at all even at the highest survey intensities. ADF&G is now applying a sightability correction factor of 1.2 to the GeoSpatial estimates for GMU 20A (unpublished data, Don Young, pers. comm. 2007).

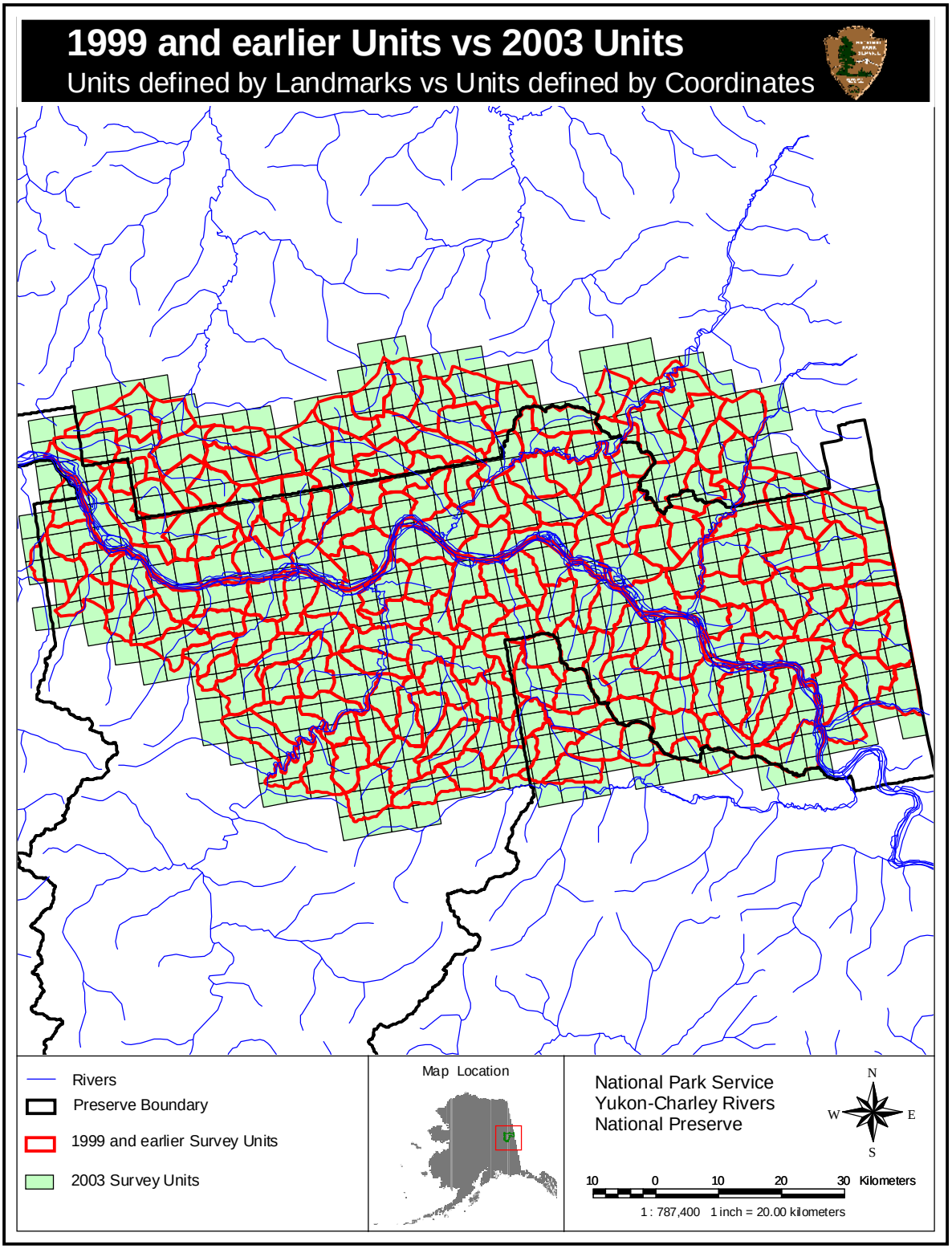

Figure 4. Survey units from 1987, 1997 and 1999 surveys (based on Gasaway et al 1986) compared to the units for the 2003 and 2006 survey (as modified by Ver Hoef 2001) in Yukon-Charley Rivers National Preserve, Alaska.

RESULTS AND DISCUSSION

Weather and Snow conditions

The weather conditions for flying the survey were good to excellent. Survey flights were stopped for a half day due to local area fog in the river corridor. There were also occasions when wind prevented surveying in isolated areas but this did not significantly affect the survey. Snow conditions and sightability were good throughout the survey area even though only 6 inches (15 cm) of fresh snow covered the study area at the start of the survey. The snow conditions and frost in the trees and bushes remained excellent throughout the survey, producing very good sightability.

General Survey Results

One hundred and fifty-one of 555 survey units were surveyed, covering 27% of the survey area (Table 1, Figure 2). A total of 76.02 hours (4,561 minutes) of flight time was spent searching for moose for an average of 30.2 minutes per survey unit. Search intensity averaged 5.42 minutes per mi^2 (2.1 minutes/km^2). A total of 180 moose were observed (89 cows, 28 calves [including 5 sets of twins], and 63 bulls [including 6 spike/fork (yearling bulls)]) (Table 1).

Population Estimate

Extrapolating observed moose numbers and composition to the entire survey area via the GeoSpatial statistics in SMOOSE generates an overall estimated density of 0.195 moose/mi^2 (0.075 moose/km^2) and an estimate of 605 moose in the 3,095 mi^2 (8,016 km^2) study area (+/- 116 moose (489 – 721) or +/-19.21% @ 90% CI); (Table 2, Appendix A). The composition of the estimated 605 moose was: 293 cows, 97 calves, 215 bulls (of which 20 were spike/fork/yearling bulls). When a Sightability Correction Factor (SCF) of 1.2 (20%) (calculated from previous surveys) is applied, the results become an overall estimated

Table 1.November 2006 moose survey results, Yukon-Charley Rivers National Preserve, Alaska.

Unit	SE Corner Coordinates	Year	Stratum	Area Mi^2	Bulls			Cows			Lone Calf	Unk	Total Moose	Search Time	Effort Min/Mi^2
					Yrl	Med	Lrg	0calf	1calf	2calf					
2	6538-14330	2006	L	5.505	0	1	3	0	0	0	0	0	4	44	7.99
3	6538-14325	2006	L	5.505	0	0	0	0	0	0	0	0	0	30	5.45
7	6536-14345	2006	L	5.512	0	0	0	1	0	0	0	0	1	37	6.71
12	6536-14320	2006	L	5.512	0	0	1	0	0	0	0	0	1	32	5.81
17	6536-14225	2006	L	5.512	0	0	1	1	1	0	0	0	4	22	3.99
22	6534-14335	2006	H	5.519	0	0	0	0	0	0	0	0	0	33	5.98
23	6534-14330	2006	L	5.519	0	0	0	0	0	0	0	0	0	24	4.35
24	6534-14325	2006	L	5.519	0	0	0	0	0	0	0	0	0	34	6.16
26	6534-14315	2006	L	5.519	0	0	0	0	0	0	0	0	0	34	6.16
30	6534-14250	2006	L	5.519	0	0	0	0	0	0	0	0	0	17	3.08
32	6534-14240	2006	H	5.519	0	1	0	0	1	0	0	0	3	35	6.34
35	6534-14225	2006	H	5.519	0	0	0	2	0	0	0	0	2	33	5.98
39	6534-14205	2006	L	5.519	0	0	0	0	0	0	0	0	0	33	5.98
40	6534-14150	2006	H	5.519	0	0	0	0	0	0	0	0	0	28	5.07
41	6534-14145	2006	H	5.519	1	1	1	0	0	0	0	0	3	24	4.35
47	6532-14325	2006	L	5.526	0	0	0	0	0	0	0	0	0	22	3.98
51	6532-14305	2006	L	5.526	0	0	0	0	0	0	0	0	0	29	5.25
59	6532-14225	2006	H	5.526	0	0	0	0	0	0	0	0	0	29	5.25
63	6532-14205	2006	L	5.526	0	0	0	0	0	0	0	0	0	27	4.89
64	6532-14150	2006	H	5.526	0	0	2	1	0	0	0	0	3	25	4.52
65	6532-14145	2006	H	5.526	0	0	0	2	0	0	0	0	2	29	5.25
69	6530-14345	2006	L	5.533	0	0	0	0	0	0	0	0	0	27	4.88
73	6530-14325	2006	H	5.533	0	0	0	0	0	0	0	0	0	29	5.24
75	6530-14315	2006	L	5.533	0	0	0	1	0	0	0	0	1	29	5.24
77	6530-14305	2006	L	5.533	0	0	0	0	0	0	0	0	0	30	5.42
80	6530-14250	2006	H	5.533	0	0	0	0	0	0	0	0	0	49	8.86
81	6530-14245	2006	H	5.533	1	0	0	1	0	0	0	0	2	38	6.87
84	6530-14230	2006	L	5.533	0	1	0	0	0	0	0	0	1	35	6.33
91	6530-14155	2006	H	5.533	0	0	0	0	1	0	0	0	2	35	6.33
94	6530-14140	2006	L	5.533	0	0	0	0	0	0	0	0	0	28	5.06
95	6530-14135	2006	L	5.533	0	0	0	0	0	0	0	0	0	27	4.88
97	6530-14125	2006	L	5.533	0	0	0	0	0	1	0	0	3	27	4.88
99	6528-14345	2006	L	5.54	0	0	0	0	0	0	0	0	0	30	5.42
106	6528-14310	2006	L	5.54	1	1	0	0	0	0	0	0	2	35	6.32
107	6528-14305	2006	L	5.54	0	0	0	0	1	0	0	0	2	31	5.60
111	6528-14245	2006	L	5.54	0	0	0	0	1	0	0	0	2	34	6.14
114	6528-14230	2006	L	5.54	0	0	0	0	0	0	0	0	0	27	4.87
116	6528-14220	2006	L	5.54	0	0	0	0	0	0	0	0	0	30	5.42
118	6528-14210	2006	L	5.54	0	0	0	0	0	0	0	0	0	27	4.87
125	6528-14135	2006	L	5.54	0	2	0	4	0	0	0	0	6	39	7.04
141	6526-14255	2006	L	5.547	0	0	0	0	0	0	0	0	0	22	3.97
149	6526-14215	2006	L	5.547	0	0	0	0	0	0	0	0	0	25	4.51
152	6526-14200	2006	L	5.547	0	0	0	0	0	0	0	0	0	33	5.95
154	6526-14150	2006	L	5.547	0	0	0	0	0	0	0	0	0	27	4.87
159	6526-14125	2006	L	5.547	0	0	0	0	0	0	0	0	0	22	3.97
160	6526-14120	2006	L	5.547	0	0	0	0	0	0	0	0	0	28	5.05
163	6524-14345	2006	L	5.554	0	0	0	0	0	0	0	0	0	32	5.76
165	6524-14335	2006	L	5.554	0	0	0	0	0	0	0	0	0	28	5.04
168	6524-14320	2006	H	5.554	0	0	0	0	0	0	0	0	0	28	5.04
169	6524-14315	2006	H	5.554	0	0	0	0	0	0	0	0	0	41	7.38
173	6524-14255	2006	L	5.554	0	0	0	0	0	0	0	0	0	23	4.14
174	6524-14250	2006	L	5.554	0	0	0	0	0	0	0	0	0	26	4.68
178	6524-14230	2006	L	5.554	0	0	0	0	0	0	0	0	0	25	4.50
188	6524-14140	2006	L	5.554	0	0	0	0	0	0	0	0	0	31	5.58
189	6524-14135	2006	L	5.554	0	2	1	2	0	0	0	0	5	31	5.58

Table 1 continued.

Unit	SE Corner	Year	Stratum	Area Mi^2	Bulls			Cows			Lone		Total	Search	Effort
					Yrl	Med	Lrg	0calf	1calf	2calf	Calf	Unk	Moose	Time	Min/Mi^2
196	6522-14330	2006	L	5.561	0	0	0	0	0	0	0	0	0	31	5.57
201	6522-14305	2006	L	5.561	0	0	0	0	0	0	0	0	0	28	5.04
203	6522-14255	2006	L	5.561	0	0	0	0	0	0	0	0	0	20	3.60
208	6522-14230	2006	L	5.561	0	0	0	0	0	0	0	0	0	23	4.14
212	6522-14210	2006	H	5.561	0	0	2	0	0	0	0	0	2	28	5.04
213	6522-14205	2006	H	5.561	0	0	0	0	0	0	0	0	0	28	5.04
214	6522-14200	2006	H	5.561	0	2	0	2	0	0	0	0	4	35	6.29
225	6520-14345	2006	L	5.568	0	0	0	1	0	0	0	0	1	16	2.87
227	6520-14335	2006	L	5.568	0	0	1	0	0	0	0	0	1	33	5.93
230	6520-14320	2006	L	5.568	0	0	0	0	0	0	0	0	0	30	5.39
236	6520-14250	2006	L	5.568	0	0	0	0	0	0	0	0	0	17	3.05
237	6520-14245	2006	L	5.568	0	0	0	0	0	0	0	0	0	21	3.77
239	6520-14235	2006	L	5.568	0	0	0	0	0	0	0	0	0	25	4.49
245	6520-14205	2006	L	5.568	0	0	0	0	0	0	0	0	0	14	2.51
247	6520-14155	2006	L	5.568	0	0	0	0	0	0	0	0	0	12	2.16
251	6520-14135	2006	H	5.568	0	0	0	0	0	0	0	0	0	33	5.93
252	6520-14130	2006	H	5.568	0	0	0	1	0	0	0	0	1	29	5.21
254	6520-14120	2006	L	5.568	0	0	0	0	0	0	0	0	0	31	5.57
258	6518-14335	2006	H	5.575	0	0	0	4	1	0	0	0	6	57	10.22
259	6518-14330	2006	H	5.575	0	3	2	5	0	0	0	0	10	33	5.92
263	6518-14310	2006	L	5.575	0	0	0	0	0	0	0	0	0	47	8.43
264	6518-14305	2006	L	5.575	0	0	0	0	0	0	0	0	0	42	7.53
274	6518-14215	2006	L	5.575	0	0	0	0	0	0	0	0	0	24	4.30
275	6518-14210	2006	L	5.575	0	0	0	0	0	0	0	0	0	25	4.48
286	6518-14115	2006	L	5.575	0	0	0	0	0	0	0	0	0	31	5.56
288	6518-14105	2006	L	5.575	0	0	0	0	0	0	0	0	0	28	5.02
290	6516-14335	2006	L	5.582	0	1	1	0	0	0	0	0	2	23	4.12
296	6516-14305	2006	L	5.582	0	0	0	0	0	0	0	0	0	35	6.27
297	6516-14300	2006	L	5.582	0	0	0	0	1	0	0	0	2	36	6.45
300	6516-14245	2006	L	5.582	0	0	0	0	0	0	0	0	0	32	5.73
302	6516-14235	2006	L	5.582	0	0	0	0	0	0	0	0	0	52	9.32
303	6516-14230	2006	L	5.582	0	0	0	0	0	0	0	0	0	52	9.32
311	6516-14150	2006	L	5.582	0	0	0	0	0	0	0	0	0	32	5.73
314	6516-14135	2006	H	5.582	0	0	0	0	1	0	0	0	2	30	5.37
315	6516-14130	2006	H	5.582	0	0	0	1	0	0	0	0	1	30	5.37
316	6516-14125	2006	H	5.582	0	0	0	1	0	0	0	0	1	31	5.55
317	6516-14120	2006	H	5.582	0	0	0	4	0	0	0	0	4	30	5.37
318	6516-14115	2006	H	5.582	0	0	0	0	0	0	0	0	0	36	6.45
325	6514-14315	2006	L	5.589	0	0	0	0	0	0	0	0	0	23	4.12
327	6514-14305	2006	L	5.589	0	0	0	0	0	0	0	0	0	13	2.33
328	6514-14300	2006	L	5.589	0	0	0	0	0	0	0	0	0	13	2.33
330	6514-14250	2006	L	5.589	0	0	0	1	0	0	0	0	1	29	5.19
335	6514-14225	2006	H	5.589	0	0	0	0	0	0	0	0	0	30	5.37
336	6514-14220	2006	H	5.589	0	0	0	3	1	0	0	0	5	32	5.73
340	6514-14200	2006	L	5.589	0	0	0	1	0	0	0	0	1	27	4.83
343	6514-14145	2006	L	5.589	0	0	0	0	0	0	0	0	0	37	6.62
349	6514-14115	2006	L	5.589	0	0	0	0	0	0	0	0	0	20	3.58
350	6514-14110	2006	L	5.589	0	0	0	0	0	0	0	0	0	26	4.65
351	6514-14105	2006	L	5.589	0	0	0	0	0	0	0	0	0	48	8.59
357	6512-14300	2006	L	5.596	0	0	0	0	0	0	0	0	0	30	5.36
361	6512-14240	2006	H	5.596	0	0	0	0	0	0	0	0	0	27	4.82
367	6512-14210	2006	H	5.596	0	0	0	0	0	0	0	0	0	30	5.36
368	6512-14205	2006	H	5.596	0	0	0	0	1	0	0	0	2	53	9.47
372	6512-14145	2006	L	5.596	0	0	0	1	0	0	0	0	1	27	4.82
373	6512-14140	2006	L	5.596	0	0	0	0	0	0	0	0	0	32	5.72
375	6512-14130	2006	L	5.596	0	0	0	0	0	0	0	0	0	32	5.72
383	6510-14315	2006	L	5.603	0	0	2	0	0	0	0	0	2	19	3.39

Table 1 continued.

Unit	SE Corner	Date	Stratum	Area Mi^2	Bulls			Cows			Lone		Total	Search	Effort
					Yrl	Med	Lrg	0calf	1calf	2calf	Calf	Unk	Moose	Time	Min/Mi^2
390	6510-14240	2006	H	5.603	0	0	0	2	0	0	0	0	2	30	5.35
392	6510-14230	2006	H	5.603	0	0	0	0	0	0	0	0	0	32	5.71
396	6510-14210	2006	H	5.603	0	0	0	0	0	0	0	0	0	27	4.82
401	6510-14145	2006	L	5.603	0	0	0	0	0	0	0	0	0	21	3.75
411	6508-14320	2006	L	5.61	0	0	0	0	0	0	0	0	0	18	3.21
413	6508-14310	2006	L	5.61	0	0	0	0	0	0	0	0	0	27	4.81
416	6508-14255	2006	L	5.61	0	0	0	0	0	0	0	0	0	32	5.70
419	6508-14240	2006	H	5.61	0	0	0	0	0	0	0	0	0	30	5.35
420	6508-14235	2006	H	5.61	0	1	1	2	1	0	0	0	6	35	6.24
423	6508-14220	2006	H	5.61	0	1	2	1	0	0	0	0	4	38	6.77
425	6508-14210	2006	H	5.61	0	0	6	2	0	0	0	0	8	41	7.31
429	6508-14150	2006	H	5.61	0	0	0	0	0	0	0	0	0	30	5.35
434	6508-14125	2006	H	5.61	0	0	0	0	0	0	0	0	0	31	5.53
435	6508-14120	2006	H	5.61	0	1	0	7	0	0	0	0	8	40	7.13
436	6508-14115	2006	H	5.61	0	1	1	0	0	0	0	0	2	30	5.35
440	6506-14315	2006	L	5.617	0	0	0	0	0	1	0	0	3	29	5.16
447	6506-14240	2006	H	5.617	0	0	0	0	1	0	0	0	2	38	6.77
453	6506-14210	2006	H	5.617	0	1	1	2	1	0	0	0	6	30	5.34
456	6506-14155	2006	H	5.617	0	0	0	0	1	0	0	0	2	25	4.45
458	6506-14145	2006	H	5.617	0	0	0	0	0	0	0	0	0	25	4.45
478	6504-14220	2006	L	5.624	0	2	0	0	0	0	0	0	2	35	6.22
481	6504-14205	2006	H	5.624	2	0	1	0	0	0	0	0	3	40	7.11
485	6504-14145	2006	H	5.624	0	0	0	0	1	0	0	0	2	38	6.76
488	6504-14130	2006	L	5.624	0	0	0	0	0	0	0	0	0	30	5.33
493	6504-14105	2006	L	5.624	0	0	0	0	1	2	0	0	8	29	5.16
497	6502-14300	2006	L	5.631	1	2	1	4	0	0	0	0	8	26	4.62
498	6502-14255	2006	H	5.631	0	0	0	0	0	0	0	0	0	36	6.39
501	6502-14240	2006	L	5.631	0	0	0	0	0	0	0	0	0	26	4.62
508	6502-14205	2006	H	5.631	0	0	0	1	0	0	0	0	1	27	4.79
518	6502-14115	2006	L	5.631	0	0	0	0	0	0	0	0	0	33	5.86
527	6500-14230	2006	L	5.638	0	0	0	0	0	0	0	0	0	30	5.32
535	6500-14150	2006	H	5.638	0	0	3	4	0	0	0	0	7	38	6.74
537	6500-14140	2006	H	5.638	0	0	0	0	2	1	0	0	7	47	8.34
538	6500-14135	2006	H	5.638	0	0	0	0	0	0	0	0	0	34	6.03
544	6500-14105	2006	L	5.638	0	0	0	0	0	0	0	0	0	24	4.26
557	6458-14135	2006	H	5.645	0	0	0	1	0	0	0	0	1	32	5.67
560	6458-14120	2006	L	5.645	0	0	0	0	0	0	0	0	0	31	5.49
561	6458-14115	2006	L	5.645	0	0	0	0	0	0	0	0	0	16	2.83
	Total			841.5	6	24	33	66	18	5	0	0	180	4561	818.37
	Average												1.19	30.21	5.42

density of 0.234 moose/mi^2 (0.091 moose/km^2) and an estimate of 726 moose in the 3,095 mi^2 (8,016 km^2) study area (+/- 139 moose (587 – 865) or +/-19.21% @ 90% CI); (Table 2). The composition of the estimated 726 moose was: 352 cows, 116 calves, 257 bulls (of which 24 were spike/fork/yearling bulls).

Table 2. November 2006, moose survey population estimate, Yukon-Charley Rivers National Preserve, Alaska. Results from the GeoSpatial Estimator. Also see the GeoSpatial Estimator output in Appendix A.

STRATUM	LOW	HIGH	TOTAL
Total no. of survey units	394	161	555
Total area (mi^2)	2197	899	3096
No. of units surveyed	97	54	151
Area surveyed (mi^2)	540	301	841
No. of moose seen	64	116	180
Density (moose/mi^2)			0.195
Density with 1.2 SCF			0.234
Estimate Total			605
Estimate with 1.2 SCF			726
Estimate Standard Error			70.71

80% Confidence Interval = (515, 695) = +/- 90 = +/- 14.97%
90% Confidence Interval = (489, 721) = +/- 116 = +/- 19.21%
95% Confidence Interval = (466, 744) = +/- 139 = +/- 22.89%
(no SCF)

Sex and Age Composition

The sex and age composition of the 180 observed moose were as follows: 89 cows, 63 bulls, and 28 calves. Composition of the observed bulls included 6 yearling bulls (small spiked or forked antlers), 24 medium bulls, and 33 large bulls. Only 1 medium single-antlered bull was seen, therefore antler shed did not appear to be a problem. Bulls begin to lose their antlers in late November, so that if surveys are conducted after this time sex ratios can become increasingly inaccurate and are impossible in a spring (March) survey because bulls cannot be identified from cows consistently from aircraft.

The estimated sex and age ratios of the population were 33 calves:100 cows, 7 spike/fork (yearling bulls):100 cows, and 73 bulls:100 cows, twinning rate was 6.89 twins:100 cows. During this November 2006 survey, 5 sets of twins were seen, in 2003 only 1 set of twins was seen, in 1999 six sets of twins were seen, in 1997 three sets of twins were seen, and in 1994 a single set of twins was seen.

The total number of yearlings is estimated by doubling the number of yearling bulls, by assuming a 50:50 sex ratio. This would make the ratio 14 yearlings:100 cows. However, the yearling component of the population is likely under-estimated because we only classified those bulls with spike or forked antlers as yearlings. Studies conducted by ADF&G indicate that yearling bulls can grow larger palmated antlers up to 30 inches (76 cm), and spike/fork bulls may represent only 40%-60% of the yearling cohort in a given year assuming adequate nutrition (Gasaway et al. 1983, Gasaway et al. 1992). Therefore, if we assume that spike/fork bulls represent 60% of the yearling cohort in YUCH, an additional 40% would increase the total number of yearling bulls to 28 and the total number of yearlings to 56. The ratios would increase to 9.5 yearling bulls:100 cows, or 19.1 total yearlings:100 cows.

Comparisons and Trends

Several moose surveys have been conducted in the past in YUCH (Table 3). However, study objectives and budget constraints resulted in a different sampling technique in 1987 and a different survey area (although overlapping) and much shorter search intensity for the 1994 survey. Comparisons of the earlier surveys (1987 and 1994) with the last four (1997, 1999, 2003, 2006) are difficult and perhaps inappropriate, because comparing these data may result in misleading or

erroneous conclusions. The aerial moose surveys conducted in November 1997, 1999, 2003 and 2006 covered the same area, using directly comparable methods. The 1994, 1997 and 1999 surveys used techniques based on Gasaway et al.(1986). The 2003 and 2006 surveys also used the techniques based on Gasaway et al. (1986) but as modified by Ver Hoef (2001) (DeLong 2006, Kellie and DeLong 2006).

Table 3. November moose survey data from past years for Yukon-Charley Rivers National Preserve, Alaska. Population estimates for 1987 and 1994 data are not directly comparable to 1997, 1999, 2003 and 2006. Composition ratios are probably comparable.

Year	Bull:Cow ratio	Calf:Cow ratio	Yrlbull:Cow ratio[1]	Density moose/mi^2	Population estimate
1987[2]	121	10	14	0.62	1116 (no CI)
1994[2]	84	21	7	0.31	735 (+/-166)
1997	60	28	8	0.27	737 (+/-148)
1999	51	36	5	0.36	979 (+/- 188)
2003[3]	61	25	6	0.265	835 (+/- 199)
2006[3]	73	33	7	0.234	726 (+/- 139)

[1] spike fork bulls only, not corrected

[2] not directly comparable with later surveys

3 sightability correction factor of 1.2 applied to Geo Spatial Estimates

The primary differences between the 1994 survey and the surveys that followed, were search intensity and boundaries of the survey area. The 1994 survey was conducted at a lower search intensity (about 1 minute/mi^2; Dale et al. (1994). Moose density in the 1200 mi^2 overlap area was estimated at 0.34 moose/mi^2 during 1994, 0.23 moose/mi^2 during 1997, and 0.23 moose/mi^2 for the 1999 survey (Burch 1999). No significant trend can be measured in the moose population from 1994 to 2006 as illustrated by overlapping confidence intervals (Table 3, Figure 5). Variation in moose densities between years could be the result of many things including immigration and emigration, changes in survival due to snow depth, changes in habitat and forage quantity and quality (succession of browse species), in addition to predation by both wolves and

bears. These data will become more valuable when combined with future years of comparable data collected within the framework of the long-term monitoring program of the Central Alaska Network. This will allow identification of trends in YUCH moose densities, and help begin to determine the primary limiting factors of YUCH's moose population.

Moose densities in YUCH (at 0.234 moose/mi^2) appear to be among the lowest reported in the region, and age and sex ratios of the moose population in YUCH are typical of other low-density populations in interior Alaska (Gasaway et al. 1992). In another portion of GMU 20E (Tok West) the overall moose density in November 2006 was 0.98 moose/mi^2 with 37 calves and 39 bulls per 100 cows (Jeff Gross pers. comm. 2007). In Denali National Park (a predominately unhunted population of moose) Owen and Meier (2005) report an overall density of 0.29 moose per square mile and 39 calves, and 88 bulls per 100 cows. In GMUs 25A, 25B, 25D (down the Yukon River from YUCH) moose densities were 0.6 moose/mi^2 with 30 calves and 50 bulls per 100 cows (Stephenson 1996). A survey conducted in Western Yukon Flats National Wildlife Refuge in November of 2004 reported a density of 0.23 moose/mi^2 and 35 calves and 72 bulls per 100 cows, and in November 2001 reported 0.29 moose/mi^2 with 52 bulls and 27 calves per 100 cows (Bertram 2005). This is in contrast with GMU 20A south of Fairbanks where moose densities have been much higher at 3.1 moose/mi^2 and 34 calves and 39 bulls per 100 cows for November 2006 (Don Young, pers. comm. 2007).

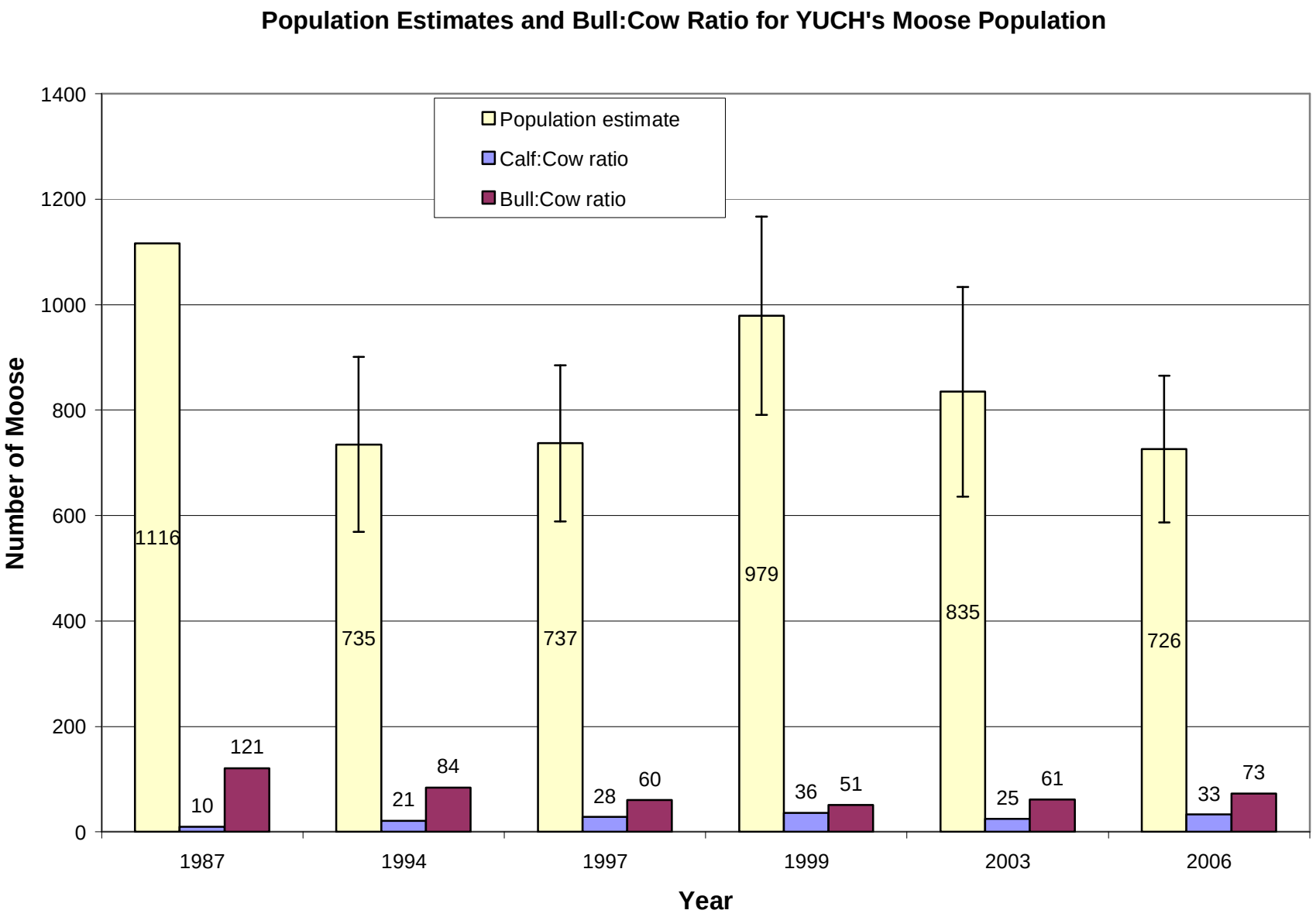

Figure 5. Trends in moose population size, calf:cow ratios and bull:cow ratios 1987 – 2006. Yukon-Charley Rivers National Preserve, Alaska. A sightability correction factor applied to all estimates including the 2003 and 2006 Geo Spatial estimates.

Harvest

Moose harvest and hunter success from 1983 to 2006 was summarized from ADF&G harvest data (Table 4 and Figure 6). The area covered includes all Uniform Coding Units (UCUs) within the 3 Game Management Units (GMU) and subunits that are completely or partially within YUCH (Figure 7). Moose harvest in YUCH has averaged 26 bulls/yr over the past 23 years (range 12-41, SE=2.08) and there has been a significant increase in moose harvest overall (r^2= 0.434, F=13.83, p=0.002, α =0.05). The average moose harvest for the first 10 years (Av=19.8, SE=2.39) is significantly lower than the average of the last 10 years (Av=29.3, SE=1.94; t=-4.43, p<0.0017, α =0.05). These tests indicate a significant increase in the number of moose harvested since 1983. During 1983-2006, an average of 91 hunters (range 41-168, SE=6.59) hunted moose in the preserve each year, spending an average of 8 days per hunt (data from1983-2002 only). Comparing the average number of hunters from the first 10 years (65) to the last 10 years (110) indicates a significant increase in the number of people hunting in the preserve (t=-6.99, p<0.001, α =0.05). Furthermore, there is also a significant trend in the increase in the number of hunters over the 23 year period (r^2=0.77, F=58.58, p<0.001, α=0.05). Reported hunter success has averaged 30.3% (range 12-46%) during this 23 year period. Average hunter success during the first 10 years (31.8) is not significantly different from the last 10 years (38.3; t=0.219, p=0.832, α =0.05) showing the success of hunters has remained about the same, even though the average number of hunters has increased. Moose hunting in the preserve occurs primarily along the main rivers such as the Yukon, Kandik, Nation, and Charley Rivers. Hunters also use airstrips and remote landing areas within YUCH, but few moose are harvested considerable distances from the main rivers (Fig. 7).

Table 4. Reported moose harvest, number of hunters, hunter effort and success in Yukon-Charley Rivers National Preserve, Alaska, 1983 to 2006.

Year	Moose Harvested	Number of Hunters	Percent Success	Hunter Effort Days/Moose	Hunter Days
1983	21	59	36	28	597
1984	19	46	41	17	326
1985	19	41	46	21	399
1986	13	48	27	20	260
1987	14	57	25	30	413
1988	17	66	26	27	464
1989	17	61	28	28	476
1990	35	81	43	15	538
1991	31	90	34	24	747
1992	12	100	12	62	739
1993	36	93	39	20	719
1994	32	126	25	29	926
1995	33	99	33	24	797
1996	24	94	26	33	793
1997	24	100	24	35	851
1998	37	80	46	22	828
1999	41	116	35	24	987
2000	38	102	37	23	873
2001	25	145	17	45	1117
2002	34	129	26	28	952
2003	20	168	12	N/A	N/A
2004	26	104	25	N/A	N/A
2005	24	87	28	N/A	N/A
2006	29	83	35	N/A	N/A
Total	621	2175	727	556	13802
Mean	25.9	90.6	30.3	27.8	690.1
first 10yr mean	19.8	64.9	31.8	27.2	495.9
last 10yr mean	29.3	109.8	28.3	28.4	884.3
last 5yr mean	26.6	114.2	25.2	28.4	951.4

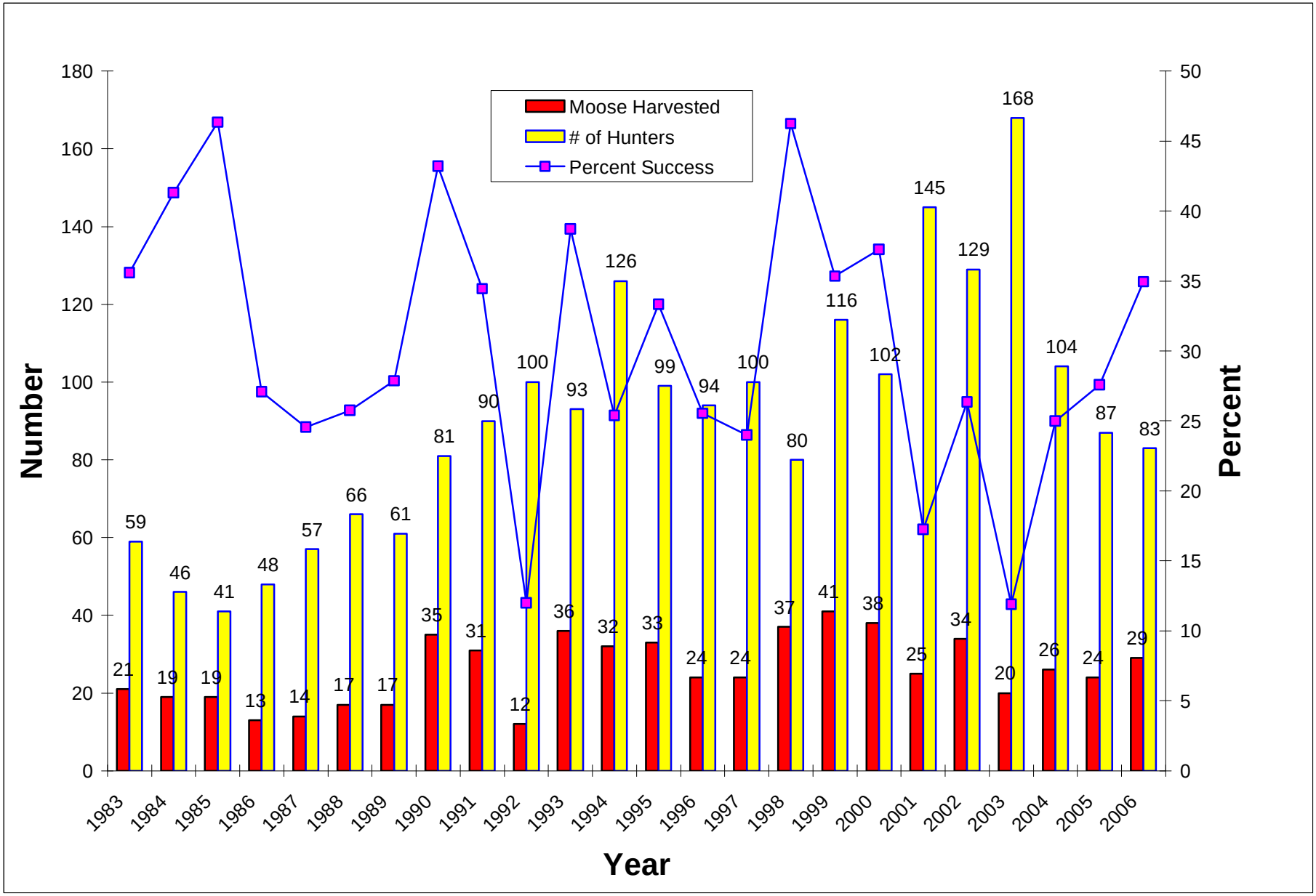

Figure 6. Reported moose harvest, number of hunters, and hunter success in Yukon-Charley Rivers National Preserve, Alaska, 1983- 2006 (data gathered from ADF&G harvest reports).

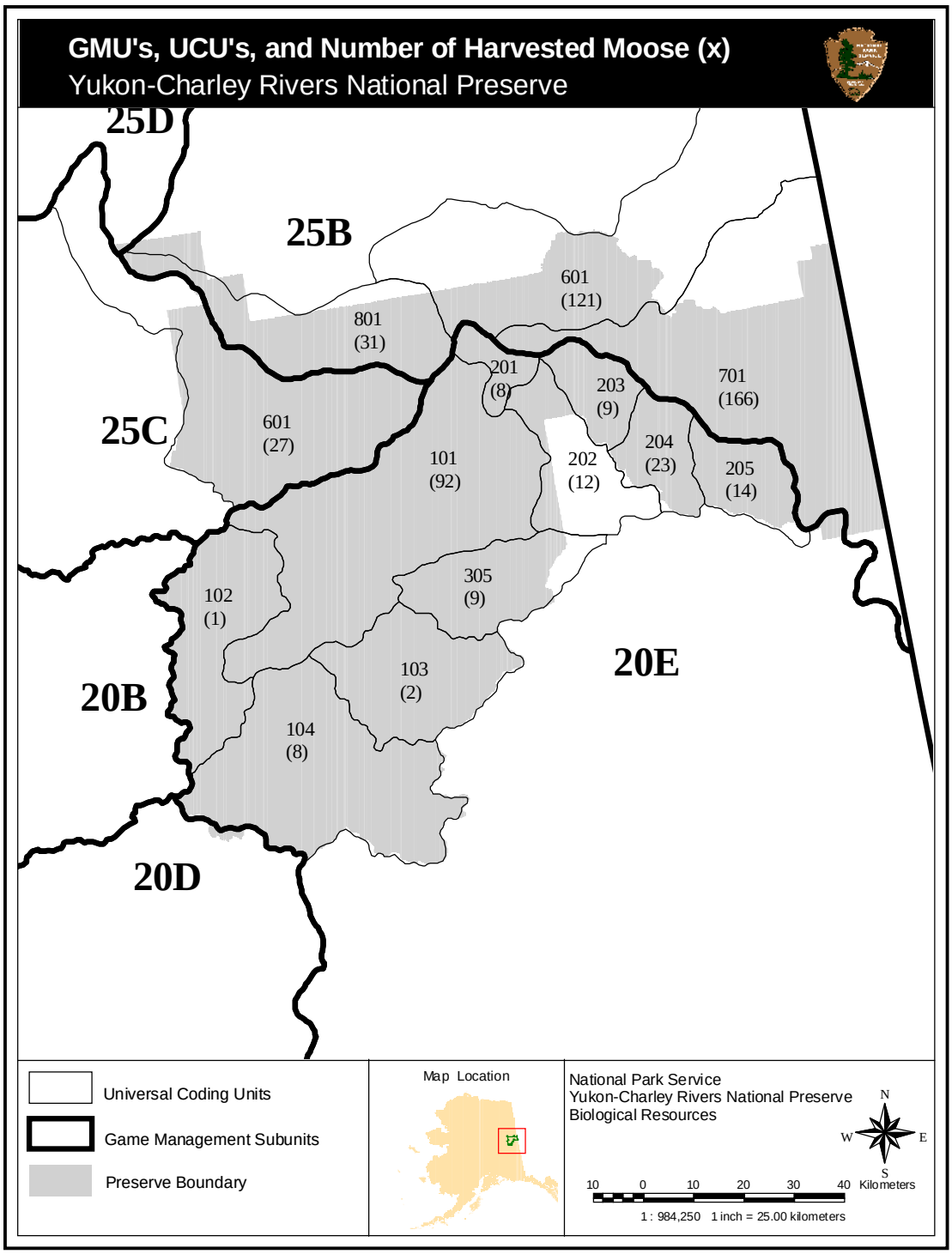

Figure 7. Game management subunits and uniform coding units (UCUs) comprising Yukon-Charley Rivers National Preserve, Alaska. Numbers in parentheses are number of moose reported harvested from 1983-2006 for each UCU.

Natural Mortality

We know very little about the natural mortality of moose in YUCH. Nearby studies over past years indicate that predation by both black and brown bears on newborn calves can be significant in the spring, and wolf predation on calves and adults is significant. From 1981-1988, ADF&G intensively studied the moose population in the Fortymile drainage south of YUCH where, in a study of 33 radiocollared newborn calves, 82% died within 11 months (52% by grizzly bears, 15% by wolves, 3% by black bears, and 12% drowned) (Gasaway et al. 1992). In the same study they found survival rates of adult moose to range from 78% to 93%. In 1998 and 1999 in Yukon Flats National Wildlife Refuge, data from a moose calf mortality study found 32 of 80 (40%) collared calves were killed by bears (17 by black bears, 15 by brown bears) and only a single calf known to be killed by a wolf, although there were 26 mortalities of unknown cause (Bertram and Vivion 2002). A moose study in Denali National Park and Preserve calculated survival rates for adult cows at 86%, 88%, and 94% for the years 2000, 2001, 2002 respectively, but causes of mortality were not identified (Layne Adams, USGS/BRD personal communication, 2004).

Wolf predation is a common cause of death of adult moose as well as calves in YUCH (Burch 2002). During routine radiotracking flights from an on-going wolf study in YUCH, there has been no significant trend in locations of wolves on moose kills from 1993 – 2006 ($r^2 = 0.027$, $F=0.335$ $p=0.56$, $\alpha=0.05$) (Table 5) (Burch 2002).

Table 5. Number of moose kills observed with radiocollared wolf packs.

Calendar Year	Total Locations	Moose kills	%Moose kills
1993	189	5	2.6
1994	286	21	7.3
1995	268	17	6.3
1996	113	11	9.7
1997	353	22	6.2
1998	435	8	1.8
1999	346	7	2.0
2000	300	10	3.3
2001	303	16	5.3
2002	200	13	6.5
2003*	74	3	4.1
2004*	54	3	5.5
2005*	98	3	3.1
2006	180	10	5.6

* very few radiotelemetry flights due to budget constraints.

Distribution of Moose

From the survey locations of moose groups in November it appears that moose congregate in the hills on either side of the Yukon in the late fall. This is illustrated by the distribution of moose groups from the 1997, 1999, 2003, and 2006 surveys (locations covering only the moose survey area), and the distribution of wolf-killed moose from 1993-2006 throughout YUCH (Figure 8). Assuming that most moose are shot near the Yukon River or its major tributaries in September, this could indicate moose migrating into the hills in the late fall, or that one portion of the population is absorbing the majority of the harvest. It is possible some moose may move farther, and the population in the Yukon valley during the September hunt is higher than indicated by moose surveys in November. The scatter of wolf- killed moose throughout the preserve

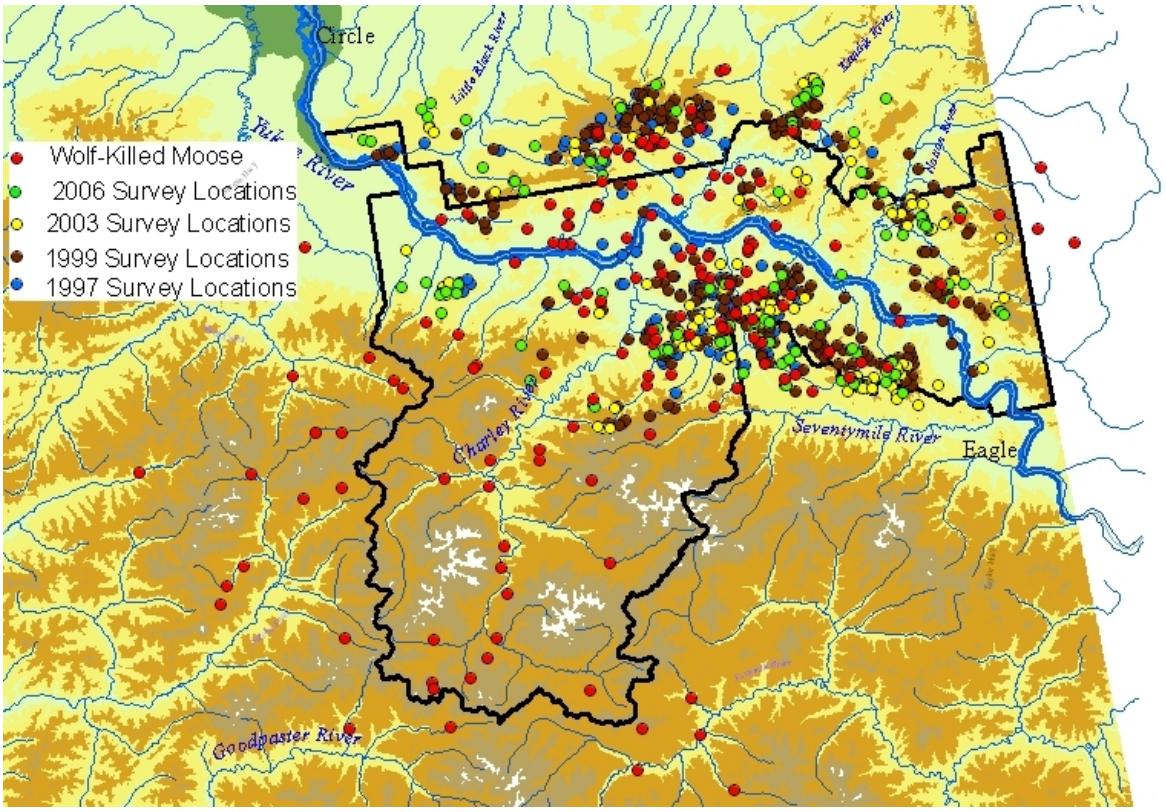

Figure 8. Distribution of moose group locations from 1997, 1999, 2003, and 2006 surveys and the distribution of wolf-killed moose (red dots) from 1993-2006, in Yukon-Charley Rivers National Preserve, Alaska.

and beyond, gives some idea of moose distribution outside the surveyed areas (Figure 8). When the wolf-killed moose locations are viewed alone, it shows a preponderance of moose in the hills of the Yukon Valley and fewer moose kills in the upper Charley River area. This coincides with local knowledge, human harvest locations, and the 1994 moose survey, all indicating fewer moose in the upper Charley.

CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

The overall density of 0.234 moose/mi^2 is among the lowest reported in interior Alaska (Gasaway et al. 1992). The population estimates and sex and age composition of the YUCH moose population appears consistent with that of a low density, stable population.

While the number of hunters has increased since the early 1980s, hunter success rates have remained comparable to the 20 year average. A proposal to lengthen the federal subsistence hunting season on bulls and to remove antler size restrictions for harvestable bulls was adopted in 1998, changing the season dates within YUCH. Since 1998, federal subsistence regulations now include August 29-31 making a subsistence season that extends from August 20 to September 30 for any bull (a change from one bull with spike-fork antlers from August 20-August 28, and no season from August 29-August 31). A proposed March hunting season was not adopted but could be proposed again in the future. The YUCH moose population could be at the maximum sustainable harvest levels right now. Extending hunting seasons to include a March season and the subsequent additional harvest could adversely affect YUCH's moose population.

Another factor complicating moose management in YUCH is the lack of knowledge of moose movements in and adjacent to YUCH. Studies of other moose populations in interior Alaska have documented significant moose movements (Hobgood and Durtsche 1990, Gasaway 1992, Dale and Boertje unpublished data). Some of these movements are migratory in nature and occur seasonally (spring and fall). Anecdotal information suggests that snow and other factors may influence the timing and magnitude of movements. These movements could affect the results of moose surveys, and the November survey results may not be representative of the moose

population during the August/September moose hunt. Information on the timing and extent of moose movements within and adjacent to YUCH is critical in order for managers to develop and implement an appropriate monitoring protocol that will contribute to science-based management decisions.

Available moose population information for YUCH is adequate for past management decisions, but surveys need to continue for future management decision making. A long-term monitoring program with consistent sampling techniques has been implemented to track the status of the YUCH moose population, through the vital signs monitoring program of the Central Alaska Network. A Geo Spatial population survey modeled after Gasaway et al. (1986) and modified by Ver Hoef (2001) (Kellie and DeLong 2006) should be conducted every 3 years, and would cost about $25,000 – $30,000 per survey. The next survey should occur in fall 2009. This monitoring level would provide managers with statistically reliable population estimates and a consistent means to estimate sex and age composition. In addition, a study of moose movements in YUCH would provide valuable information to assist in determining an appropriate population monitoring protocol and allow managers to make informed decisions regarding moose management to maintain healthy populations for future generations.

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APPENDIX A. Output from the Geospatial population estimator software (Ver Hoef 2001, DeLong 2006, Kellie and DeLong 2006). No sightability correction factor (SCF) applied.

Moose Population Estimate--Geo Technique

Survey: YUKON-CHARLEY
Year: 2006
Season: Fall

REQUEST PARAMETERS	
Analysis Column:	[TotalMoose]
Analysis Area:	InTotSurvey
Strata Column:	StratName
Counted Column:	Counted
Unit Area Column:	AreaMi
Right click to download data used to calculate estimate.	
Right click to download RCode used to calculate estimate.	

RESULTS

Estimate	
Population Estimate:	605.3389
Standard Error:	70.71313

Confidence Intervals		
Confidence	Interval (moose)	Interval (proportion of the mean)
80%	514.7163 695.9614	0.1497054
90%	489.0261 721.6516	0.1921449
95%	466.7437 743.9341	0.2289547

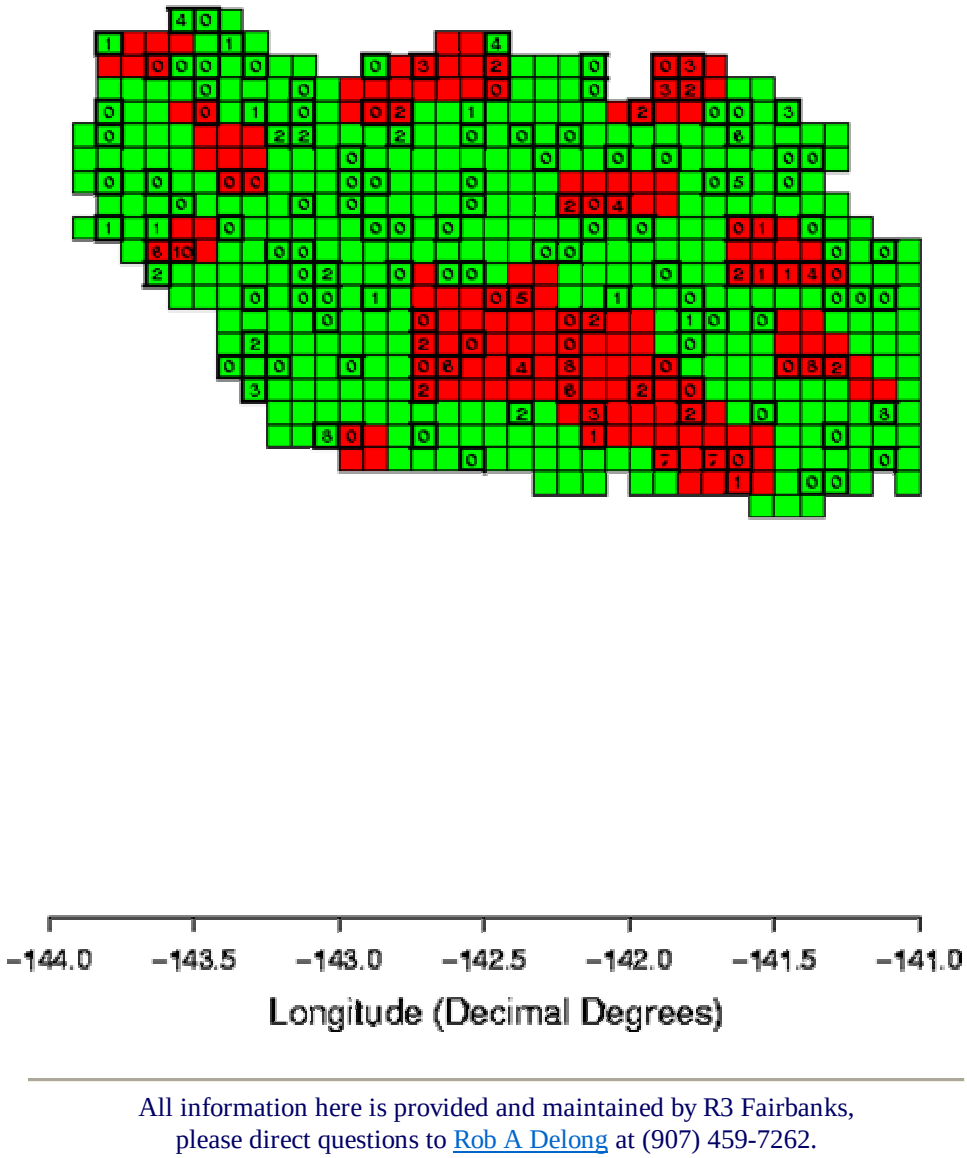
SAMPLE DETAILS

Total Samples	Stratum N 1 High 161 2 Low 394 3 TOTAL 555
Total Area	Stratum Area 1 High 898.769 2 Low 2197.037 3 TOTAL 3095.806
Sample Sizes	Stratum n 1 High 54 2 Low 97 3 TOTAL 151
Area Sampled	Stratum Area 1 High 301.465 2 Low 539.981 3 TOTAL 841.446
Moose Counted	Stratum Counted 1 High 116 2 Low 64 3 TOTAL 180

ESTIMATE DETAILS		
Stratum	High	Low
Empirical Semi-Variogram	distance gamma np 1 4.235652 0.2019908 82 2 9.775433 0.2074981 144 3 15.682831 0.2209798 158 4 22.009458 0.2119291 254 5 28.214001 0.1506601 248 6 34.304119 0.1667275 278 7 40.343146 0.2115916 332 8 46.474347 0.1933889 296	distance gamma np 1 4.546947 0.04314842 130 2 10.027722 0.05775188 442 3 15.619568 0.05452020 448 4 21.729935 0.05921657 774 5 28.323833 0.06286044 866 6 34.312711 0.07118851 798 7 40.553705 0.04634971 828 8 46.859357 0.08168827 664
Parameter Estimates	nugget parsil range 1 0.2085985 8.74397e-09 24.76341	nugget parsil range 1 0.07805362 6.326706e-09 24.17632

MAPS

Sampling and Stratification



All information here is provided and maintained by R3 Fairbanks,
please direct questions to Rob A Delong at (907) 459-7262.

Central Alaska Network

Denali National Park & Preserve
Wrangell-St. Elias National Park & Preserve
Yukon-Charley Rivers National Preserve

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As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environment and providing for outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interest of all our people. The department also promotes and encourages stewardship and citizen responsibility for the public lands and promoting citizen participation in their care.

June, 2007